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PLASMA ROD DECORATING OF HOUSEHOLD GLASS

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The results of studying plasma spray deposition of glass rods on household glass are discussed. It is demonstrated that decorative plasma treatment produces coatings with good consumer properties.

Plasma decorating of household glass using glass powders was proposed and implemented at the Krasnyi Mai glass factory in the early 1980s. A stencil was applied to glass articles preheated in a muffle surface to 523 K, and a plasma jet was used to spray glass powder with a grain size of 80 – 250 μm [1]. The milling of glass to obtain glass powder and subsequent fraction screening are labor- and time-consuming operations. The technology of plasma spray deposition of glass rods on household glass is a more efficient and more economically expedient technology. Spray deposition of rods has several advantages compared to powder spraying: first, it ensures a more uniform and precise feeding of the decorating material to the plasma jet; second, it excludes the deposition of non-melted glass particles on the substrate [2].

The present paper describes the results of studying plasma decorating of household glass, using glass rods as the decorating material.

The initial glass articles were manufactured at the Krasnyi Mai Glass Factory from milky glass, cobalt-tinted blue household glass, clear soda-lime glass, and barium cut glass (Table 1). The same glasses were used to make rods of diameter 0.8 – 2.5 mm.

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TABLE 1

Glass	Weight content,* %				
	SiO_2	Al_2O_3	CaO	Na_2O	K_2O
Milky	66.6	6.3	6.3	14.8	1.0
Clear	67.4	6.3	9.3	16.0	–
Cobalt-tinted household blue	68.6	6.3	9.3	14.8	1.0
Barium cut crystal	60.5	0.5	–	2.0	15.0

* Milky glass contained 5.0% F, household blue — 0.002% CoO, barium cut glass — 18.0% BaO. The content of B_2O_3 and ZnO in barium cut glass was 1.0 and 3.0%, respectively.

Decorating of glass articles was carried out with a UPU-8M serial plasma gun equipped with a GN-5r burner. The distance from the plasma burner nozzle to the surface of the glass article was 250 – 350 mm. Argon served as the plasma-forming gas, and its flow rate varied from 0.00093 to 0.00140 g/sec at a pressure of 0.24 – 0.26 MPa.

The surface of the glass articles before decorating was degreased with a cotton pad soaked in acetone or methanol, and a stencil of flexible copper or aluminum foil was applied.

In decorating (Fig. 1), a rod *2* was inserted manually or automatically into the flame of the plasma burner *2*, and the flow of melted glass particles *3* under the effect of the plasma-forming gas was spray-deposited on the glass article *4* over the stencil *5* for 15 – 30 sec, depending on the surface area and the configuration of the pattern applied to the article. As a result, a new kind of decorative coating resembling the known "flux" decoration was produced on the surface of the article.

As a consequence of the high-temperature effect of the plasma flame, the glass ingredients partly evaporated under

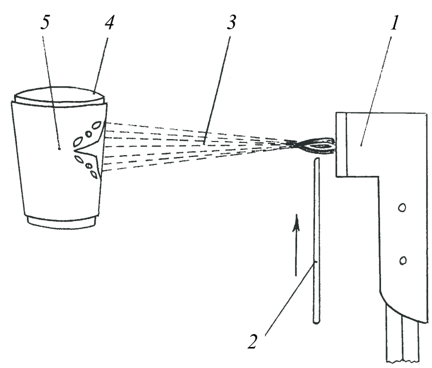

Fig. 1. Scheme of decorating household glassware.

TABLE 2

Glass	Weight content,* %											
	SiO_2		Al_2O_3		CaO		Na_2O		K_2O		BaO	
	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment
Milky	66.6	67.2	6.3	6.91	6.3	6.8	14.0	12.97	1.0	0.97	–	–
Clear	67.4	68.4	6.3	6.88	9.3	10.1	16.0	15.13	–	–	–	–
Cobalt-tinted household blue	68.6	70.1	6.3	7.11	9.3	9.9	14.8	13.71	1.0	0.96	–	–
Barium cut crystal	60.5	61.4	0.5	0.58	–	–	2.0	1.81	15.0	14.73	18.0	16.9

TABLE 3

Glass	Density, g/cm^3		Vitrification temperature, K		Sintering temperature, K		Refractive index	
	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment
Milky	2.42	2.39	781	801	812	837	1.519	1.514
Clear	2.48	2.43	796	819	845	868	1.522	1.518
Cobalt-tinted household blue	2.52	2.47	836	851	898	912	1.524	1.519
Barium cut crystal	3.02	2.91	–	–	–	–	1.541	1.536

rod treatment. Thus, in spraying rods of milky, clear, and cobalt-tinted blue glass, their compositions became depleted of alkaline-earth oxides (Na_2O and K_2O) and enriched in SiO_2, Al_2O_3, and CaO. The barium cut glass was significantly depleted of barium oxide (Table 2).

The refractive index of the glasses after the plasma treatment was determined by the immersion method [3], and the thermal properties were determined on a DKV-3 device. The content of alkaline and alkaline-earth oxides in the considered glasses was determined by the flame photometry method, that of aluminum and silicon oxides by the analytical methods, and that of barium oxide was determined according to GOST 26822–86, and the sample density before and after plasma spraying was measured by the picnometric method [4].

Partial evaporation of components under plasma treatment of glasses resulted in the modification of their viscosity, optical properties, and density (Table 3). Significant variations in these properties occurred as a consequence of the high-temperature effect of the plasma jet, which induced the nonstoichiometric state in the system $(SiO_2)_n$. Thus, domestic researchers observed that a deficit of oxygen in the amount of 0.006% was registered in quartz glasses after plasma treatment. This, in turn, determined the increase in the temperature of the start of softening by 40°C and the change in the optical parameters, compared to quartz glass produced by the traditional method [3].

The heat treatment of household glass with plasma decorative coatings was determined in accordance with GOST 26821–86. The testing demonstrated that the decorative coatings do not become destroyed in thermal cycling of blown glass articles with a temperature drop of 95 – 70 – 20°C and satisfy the standard requirements.

Thus, a decorative coating with good consumer properties is formed in the course of glass rod plasma spraying on glass substrates. This gives reason to recommend this method for the decoration of household glass in industrial conditions.

REFERENCES

1. I. I. Nemets, V. P. Krohkin, V. S. Bessmertnyi, et al., "Plasma decoration of household glass," *Steklo Keram.*, No. 4, 9 – 10 (1983).
2. L. M. Demidenko, *High-Refractory Composite Coatings* [in Russian], Metallurgiya, Moscow (1979).
3. N. M. Pavlushkin, G. G. Sentyurin, and R. Ya Khodakovskaya, *A Practical Course in the Technology of Glass and Glass Ceramics* [in Russian], Stroiizdat, Moscow (1970).
4. P. D. Sarkisov and A. S. Agarkov, *Technical Analysis and Production Control of Glass and Glass Articles* [in Russian], Stroiizdat (1972).